ARS 42-109
December 1964

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

ADAPTATION OF MICRONAIRE FOR RAMIE FIBER FINENESS[1/]

Hiram D. Whittemore and J. V. Shepherd[2/]

INTRODUCTION

Ramie is a bast fiber of Oriental origin (5, 6).[3/] Its cultivation and processing by primitive hand methods predates history. Because of unique properties that make it a desirable textile material, commercial production under modern mechanization has been undertaken in the United States and elsewhere.

Large scale mechanical production with its necessary controls of quality and uniformity can at the same time introduce damage and loss not inherent in hand production (4, 7). Quality evaluation is then a necessary part of mechanical processing.

There are methods of determining various quality factors of cotton fiber, for example, but relatively few instruments and techniques have been worked out for long fiber crops. In 1955, a research program was initiated on long vegetable fiber quality measurements at the Florida Everglades Experiment Station. Several crops were included in the study but the emphasis was on ramie. This report deals largely with investigations in the use of the Micronaire[4/] in determining ramie fiber fineness (1). The instrument is available on the market and offers some possibility of providing a relatively simple and fast method of determining ramie fiber fineness.

1/ Based on work carried out jointly by personnel of the Agricultural Engineering Research Division in cooperation with the Everglades Experiment Station of the Florida Agricultural Experiment Station.

2/ Respectively, agricultural engineer and cotton technologist, Agricultural Research Service, Agricultural Engineering Research Division.

3/ Underscored numbers in parentheses refer to Literature Cited at end of publication.

4/ Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture.

A great deal of valuable information and suggestions concerning the measurement of fiber fineness were obtained from working with the late Norma L. Pearson, cotton technologist. Also frequent recourse has been made to her unpublished progress report "Measurement of Ramie Fiber-Fineness."

Fineness is an important quality of fiber. It determines the range of products for which the fiber is suited. In general, the finer the fiber the more valuable the product that can be made from it. Producers and processors of ramie have been of the opinion that fineness increases from butt to tip of the plant. Also, it is the general belief that variety, maturity, and environment influence ramie fiber fineness.

Selection of Samples

Ramie is a perennial and the harvest season in Florida usually extends over a period of about 150 days. The crop normally is harvested several times during the season at approximately 60-day intervals. Samples for determining variations in fiber fineness from butt to tip were taken at the time of the second, or middle, harvest. Plants, all approximately the same height, were selected and cut at ground level. The sample stalks were decorticated while green, and the fiber was dried under ambient conditions.

Samples were taken at the time of each commercial harvest in selected areas for several years for studies of variation in fiber fineness from year to year. The crop at this time presumably was fully mature for fiber production purposes, and variations in fineness would reflect seasonal conditions from year to year. Other samples were taken at 40-, 50-, 60-, and 70-day periods to determine the effects of relative maturity on fineness.

The selection of varieties for fineness was planned to provide a wide range of material for Micronaire studies. This material was obtained from variety plots at the Everglades Experiment Station and variety fields maintained by a commercial producer in South Florida. All these plantings had been well tended and were considered to be relatively pure stands of each variety. Some were commonly referred to as fine ramie and others as coarse ramie. At least by repute they constituted a range of fineness required for the Micronaire work.

Varieties for Micronaire readings also included samples collected over a period of years for other studies. These samples were for the most part very small, but in some cases fineness determinations had been made by a variety of methods and at several places in the world.

Preparation of Fiber Samples

Ramie fiber is extracted from the stalk by mechanical means referred to as decortication. Before being useful for spinning the fiber undergoes a chemical processing known as degumming for the purpose of removing the gums and pectins which bind the individual fibers together. All the samples used in the fineness studies were processed by an established commercial method for uniformity and to insure that these binding agents were completely broken down.

Complete separation of the fibers was necessary for several of the testing procedures used. Carding equipment can be as simple as two hand cards or as complex as a production machine. Hand carding was time consuming and was subject to operator variation. Several machines were tried in an attempt to find a simple, small machine capable of producing uniformly opened fiber from very small samples. Since each sample was to be tested individually, the card had to be cleaned completely between samples to avoid mixing.

The equipment used in preparing the fiber samples, and that used for testing are standard and commercially available with one exception. The Neptometer used as a card was developed experimentally for related work on cotton (3).

The Shirley Analyzer, an English cotton research instrument, was used as a card (2). It was not designed for this purpose, but produced satisfactory samples.

The Neptometer (fig. 1) has a capacity of 40 grains. It requires several minutes for each of the two passes necessary to produce usable samples. After each pass through the machine, the hand cards seen in the foreground were used to remove the fiber from the card rolls.

A 20-inch Proctor-Schwartz Synthetic Sample Card was acquired later by the Everglades Experiment Station. This self-cleaning machine is excellent for sample preparation, since it can handle samples ranging from a few ounces to fairly large spinning samples.

A Wiley Mill (fig. 2) was used in some of the tests to determine if uniform and complete separation could be obtained by use of a relatively inexpensive and simple machine. Although the mill appears to grind the fiber to a powder, microscopic examination shows that the fibers actually are cut to a very short staple length--10 to 20 times the diameter--and very little cross-sectional damage results.

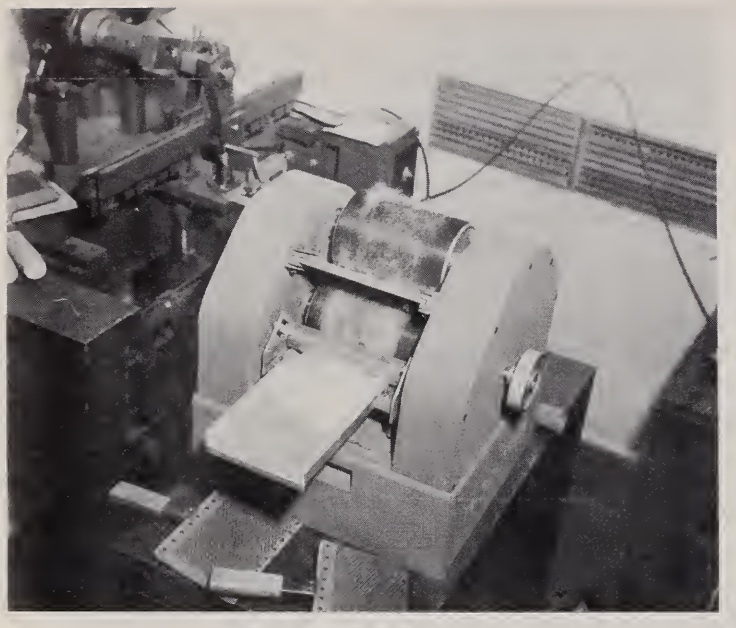

Figure 1. A Neptometer being used to prepare ramie for Micronaire studies.

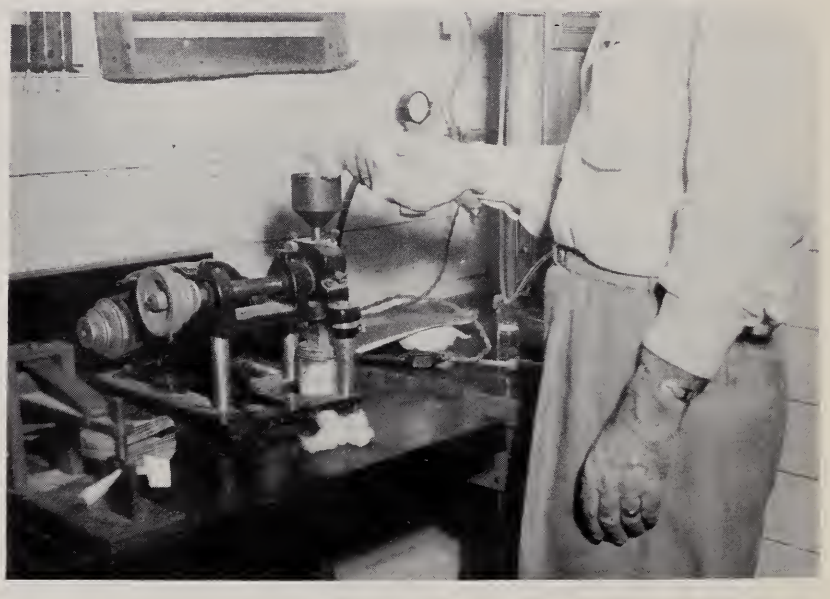

Figure 2. A Wiley Mill milling blended ramie samples for Micronaire studies.

Micronaire

The Micronaire (fig. 3) has had wide acceptance in commercial cotton testing. It employs the principle of measuring the resistance to airflow of a

Figure 3. Turning a plug of ramie in the Micronaire for a second reading.

plug of fibers as an indication of the fineness of those fibers. A predetermined weight of fibers is placed in a compression chamber and compressed to a fixed volume. Air at a fixed pressure is forced through the plug. The amount of flow is indicated by the position of a float in a vertical tube connected to the compression chamber. Fineness is then read directly on the Micronaire scale.

The Micronaire, as used for cotton, does not have a suitable scale for ramie. Ramie is coarser than the cottons commonly grown in the United States and has a wider range from fine to coarse than cotton.

Specimens of 50 grains from cotton samples are tested on the Micronaire. Preliminary tests indicated that a 60-grain plug was preferable for ramie because of the wide range of fineness. Plugs or specimens weighing 60 grains were prepared from a carded sample of well degummed ramie for the tests. These samples were placed in the compression chamber and the regular 6 p.s.i. air pressure applied. The American Upland cotton scale was used, and the tabulations represented merely the position of the float in the tube. For practical application in the trade, ratings would need be developed to cover the range of readings, such as from very fine to very coarse. And, as a final step, the relation of these ratings to the use-value of the ramie fiber would need to be established.

Denier

Denier is a term used to indicate fineness of silk, rayon, or nylon. It is the weight in grams of 9,000 meters of fibers--usually as yarn. Essentially it is an expression of weight per unit-length. For our purpose in this study combed 5-inch sections of ramie fiber were carefully separated and from these a 1-inch section was cut. One hundred fibers from these sections were weighed to determine micrograms per inch, which is the scale unit used on the Micronaire. In addition, these values could be converted to grams per 9,000 meters, a denier reading. Denier was used in this study as a reference, or check, for Micronaire readings.

Photomicrograph

Another method used for fineness determinations in the study was photomicrographs. A Hardy thin-section cutting device was used to prepare samples for microscopic slides that were subsequently magnified 250X and photographed with a photomicrographic camera to give prints with a total magnification of 500X.

The photomicrograph method was more complex than the other methods, somewhat indirect and time consuming, but capable of producing information in addition to that needed to correlate fiber measurements with Micronaire readings. Direct measurements of the major axis, minor axis, and the minor lumen were made on groups of 25 fiber cross sections. From these were computed the average diameter, wall thickness, and the ratio of the major-to-minor axis. This ratio of major-to-minor axis gave an indication of the distribution of fiber shapes; that is, roundish, elliptical, or linear. Figures 4, 5, 6, and 7 illustrate variation in shape as well as fineness of fiber in different varieties.

Figure 4. Typical mature ramie fiber cylindrical and fairly uniform in diameter.

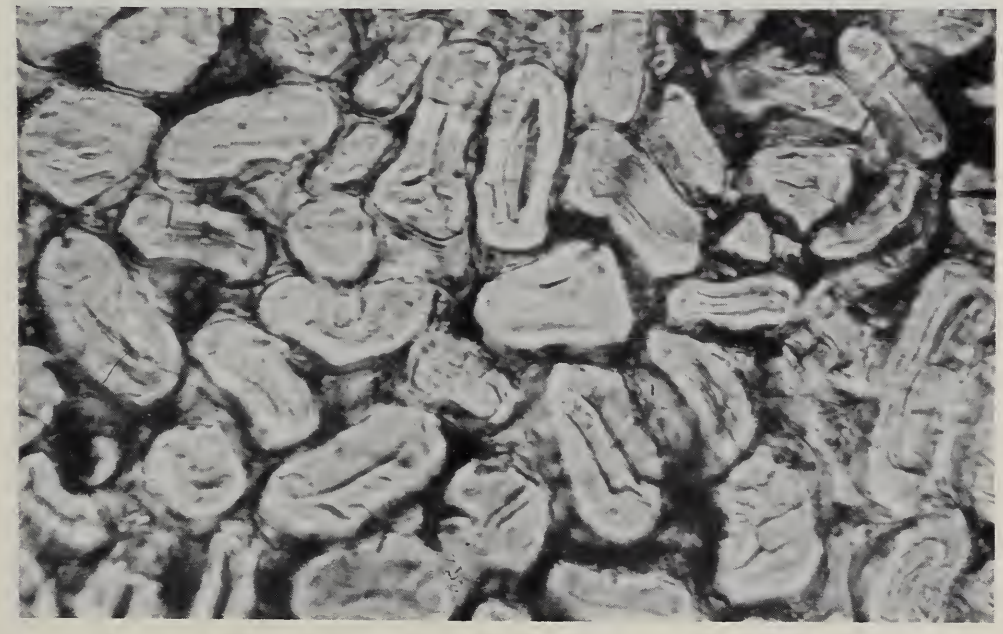

Figure 5. Coarse commercial variety of ramie.

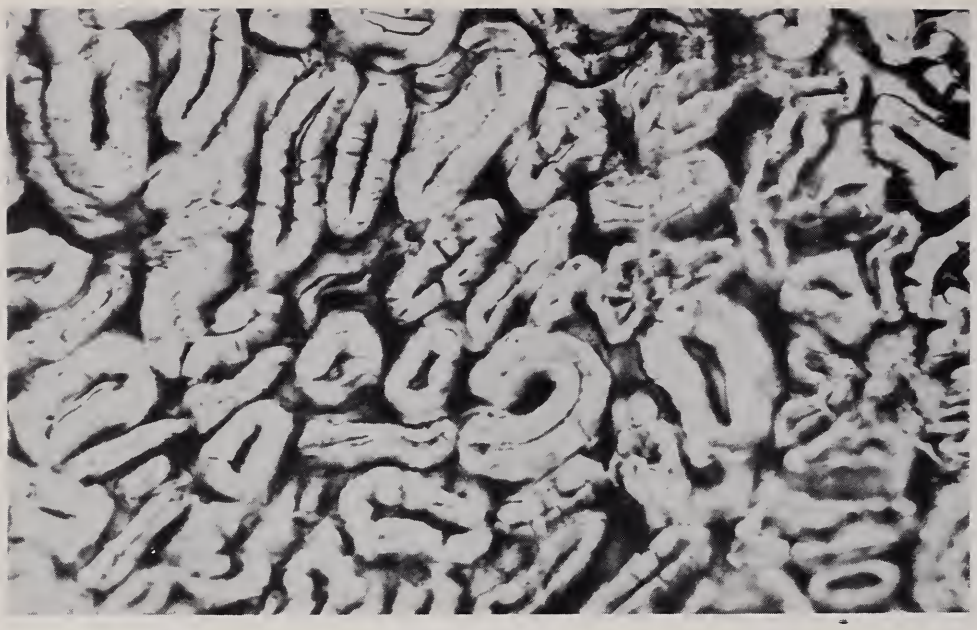

Figure 6. A ramie variety with flat and some horseshoe shaped fiber.

Figure 7. A mixed variety having a wide range of different shapes. A group of immature fibers appear in the upper left side of the picture.

Photomicrographs of ramie cross sections were used as a basis of measurement of actual fiber fineness in an attempt to correlate these measurements with those obtained on the Micronaire. Exact correlation was not possible without making thousands of measurements of each of several varieties. However, there was a very definite correlation throughout the range from coarse to fine. This indicated that the Micronaire could be adapted to give some useful indication of fineness in ramie.

Discussion

Micronaire readings and denier determinations of fiber from two varieties of ramie, one coarse and one fine, are given in table 1. The denier determinations made at different laboratories on samples of the same fiber varied. However, all determinations followed the same trends. For example, the fiber from the butt of the lower part of the plant was coarser than that from the middle, and the middle was coarser than that from the tip in both varieties. Denier also was consistent in showing varietal differences as to fineness.

The Micronaire readings reflected varietal differences as to fineness (table 1). Moreover, the readings followed the same pattern as to an increase in fineness from butt to tip as did denier. Micronaire readings of fiber from 2-inch sections cut from full-length stalks are shown graphically in figure 8. Also, there were indications that variations of fineness occurred on the same variety from harvest to harvest and from year to year. However, the most obvious differences in fineness were due to variety and to an increase of fineness from butt to tip of the plants.

Table 1. Micronaire and denier of uniform samples of ramie fiber

Sample Number and position on stalk	Micronaire-60-grain plugs [1/]		Denier			
	Carded	Milled	Germany	Japan	Switzerland	United States (Florida)
	Reading	Reading	Gr./9,000 m.	Gr./9,000 m.	Gr./9,000 m.	Gr./9,000 m.
1, A coarse fiber from:						
Butt	8.70	5.40	7.48	10.32	8.65	10.44
Middle	8.30	5.10	7.16	9.32	8.31	7.18
Tip	6.35	4.05	5.21	6.52	6.44	5.89
2, A fine fiber from:						
Butt	8.15	5.05	4.91	6.20	4.82	5.28
Middle	8.05	4.90	3.42	4.78	5.80	4.92
Tip	5.25	3.35	2.52	3.72	3.94	3.41

1/ Upland cotton scale.

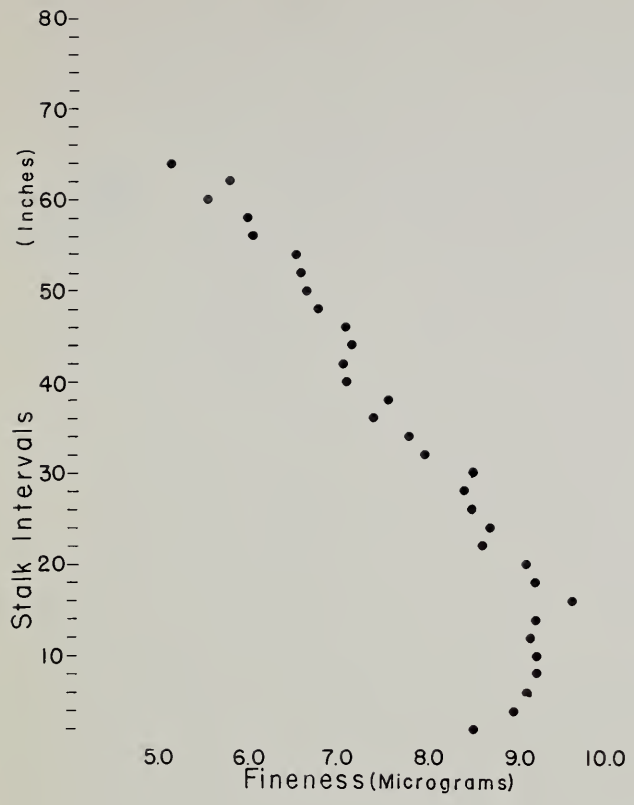

Figure 8. Fineness in ramie at 2-inch intervals from butt to tip of stalk.

CONCLUSIONS

1. The Micronaire with 60-grain plugs and the Upland cotton scale consistently reflected variation in ramie fiber from coarse to fine.

2. The cotton scales of the Micronaire are not suitable for ramie. Ramie fiber is generally coarser than cotton grown in the United States and has a wider range than cotton from fine to coarse.

3. For practical application of the Micronaire: (a) Ratings would need be developed to cover the range of readings from very fine to coarse, and (b) relation between these readings and use-value would need to be developed.

4. Micronaire readings followed the same trends on samples from coarse and fine varieties of ramie and on butt, middle sections, and tips as denier determinations.

5. Observations and measurements made of ramie fiber cross section with total magnification of 500X agreed with denier determinations and Micronaire readings as to range of ramie fineness from coarse to fine.

6. Micronaire readings, denier determinations, and photomicrograph measurements showed that fineness is influenced by variety from butt to tip of plant, maturity, and seasonal environment.

Literature Cited

(1) American Society for Testing Materials.

1963. Standard method of test for micronaire reading of cotton fibers. ASTM Standards on Textile Materials, D 1448-59.

(2) ___

1963. Standard method of test for non-lint content of cotton (shirley analyzer method). ASTM Standards on Textile Materials, D 1451-59.

(3) Bogdan, J. F.

1954. Measurement of the nepping potential of cotton. Textile Res. Jour. 24: 491-494.

(4) Byrom, M. H.

1956. Ramie production machinery. U. S. Dept. Agr. Agr. Inform. Bul. 156, 20 pp., illus.

(5) Dall, W. B.

1945. Ramie - has tantalized textile men for one hundred years. Textile World 95: 93-98, 206-210.

(6) Mauersberger, H. R., ed.

1954. Ramie. In Matthews' Textile Fibers: pp. 298-313. John Wiley & Sons, Inc., New York.

(7) Whittemore, H. D., Byrom, M. H., and Hellwig, R. E.

1963. Mechanical harvesting and ribboning of ramie fiber. U. S. Dept. Agr. Prod. Res. Rpt. 65, 26 pp., illus.